# CONTENTS

	Page	
PREFACE	iii	
FIGURES		
ABSTRACT	1	
1. INTRODUCTION 1.1 Background 1.2 Authority 1.3 Purpose 1.4 Extrapolation of Spectrum Occupancy Data	1 2 2	
2. SAN FRANCISCO SPECTRUM SURVEY 2.1 Introduction	3	
3. CONCLUSIONS	92	
4. REFERENCES	94	
APPENDIX A: OVERVIEW OF BROADBAND SPECTRUM SURVEYS	95	
APPENDIX B: INTERPRETATION OF SPECTRUM SURVEY DATA	105	
APPENDIX C: RADIO SPECTRUM MEASUREMENT SYSTEM	119	
APPENDIX D: DATA ACQUISITION SOFTWARE	131	

### **FIGURES**

		Page
Figure 1.	Regional map of San Francisco, California showing the location of all three RSMS measurement sites	6
Figure 2.	Regional map of San Francisco, California showing areas that are line-of-sight from the measurement site at Grizzly Peak	7
Figure 3.	Regional map of San Francisco, California showing areas that are line-of-sight from the measurement site at Yerba Buena	8
Figure 4.	Regional map of San Francisco, California showing areas that are line-of-sight from the measurement site at Angel Island	9
Figure 5.	Summary graph of 108-138 MHz measurements at Grizzly Peak	11
Figure 6.	Summary graph of 108-138 MHz measurements at Yerba Buena	12
Figure 7.	Summary graph of 138-162 MHz measurements at Grizzly Peak	13
Figure 8.	Summary graph of 138-162 MHz measurements at Yerba Buena	14
Figure 9.	Summary graph of 162-174 MHz measurements at Grizzly Peak	15
Figure 10.	Summary graph of 162-174 MHz measurements at Yerba Buena	16
Figure 11.	Summary graph of 174-216 MHz measurements at Grizzly Peak	17
Figure 12.	Summary graph of 174-216 MHz measurements at Yerba Buena	18
Figure 13.	Summary graph of 216-225 MHz measurements at Grizzly Peak	19
Figure 14.	Summary graph of 216-225 MHz measurements at Yerba Buena	20
Figure 15.	Summary graph of 225-400 MHz measurements at Grizzly Peak	21
Figure 16.	Summary graph of 225-400 MHz measurements at Yerba Buena	22
Figure 17.	Summary graph of 400-406 MHz measurements at Grizzly Peak	23
Figure 18.	Summary graph of 400-406 MHz measurements at Yerba Buena	24
Figure 19.	Summary graph of 406-420 MHz measurements at Grizzly Peak	25

## **FIGURES** (Continued)

		Page
Figure 20.	Summary graph of 406-420 MHz measurements at Yerba Buena	26
Figure 21.	Summary graph of 420-450 MHz measurements at Grizzly Peak	27
Figure 22.	Summary graph of 420-450 MHz measurements at Yerba Buena	28
Figure 23.	Summary graph of 450-470 MHz measurements at Grizzly Peak	29
Figure 24.	Summary graph of 450-470 MHz measurements at Yerba Buena	30
Figure 25.	Summary graph of 470-512 MHz measurements at Grizzly Peak	31
Figure 26.	Summary graph of 470-512 MHz measurements at Yerba Buena	32
Figure 27.	Summary graph of 512-806 MHz measurements at Grizzly Peak	33
Figure 28.	Summary graph of 512-806 MHz measurements at Yerba Buena	34
Figure 29.	Summary graph of 806-902 MHz measurements at Grizzly Peak	35
Figure 30.	Summary graph of 806-902 MHz measurements at Yerba Buena	36
Figure 31.	Summary graph of 902-928 MHz swept measurements at Grizzly Peak	37
Figure 32.	Summary graph of 902-928 MHz swept measurements at Yerba Buena	38
Figure 33.	Summary graph of 902-928 MHz stepped measurements at Grizzly Peak	39
Figure 34.	Summary graph of 902-928 MHz stepped measurements at Yerba Buena	40
Figure 35.	Summary graph of 928-960 MHz measurements at Grizzly Peak	41
Figure 36.	Summary graph of 928-960 MHz measurements at Yerba Buena	42
Figure 37.	Summary graph of 960-1215 MHz measurements at Grizzly Peak	43
Figure 38.	Summary graph of 960-1215 MHz measurements at Yerba Buena	44
Figure 39.	Summary graph of 1215-1400 MHz measurements at Grizzly Peak	45
Figure 40.	Summary graph of 1215-1400 MHz measurements at Yerba Buena	46

## **FIGURES** (Continued)

		Page
Figure 41.	Summary graph of 1350-1400 MHz measurements at Grizzly Peak	47
Figure 42.	Summary graph of 1350-1400 MHz measurements at Yerba Buena	48
Figure 43.	Summary graph of 1400-1530 MHz measurements at Grizzly Peak	49
Figure 44.	Summary graph of 1400-1530 MHz measurements at Yerba Buena	50
Figure 45.	Summary graph of 1530-1710 MHz measurements at Grizzly Peak	51
Figure 46.	Summary graph of 1530-1710 MHz measurements at Yerba Buena	52
Figure 47.	Azimuth-scan graph of 1710-2300 MHz measurements at Angel Island	53
Figure 48.	Summary graph of 2300-2500 MHz measurements at Grizzly Peak	54
Figure 49.	Summary graph of 2300-2500 MHz measurements at Yerba Buena	55
Figure 50.	Azimuth-scan graph of 2500-2700 MHz measurements at Angel Island	56
Figure 51.	Summary graph of 2700-2900 MHz measurements at Grizzly Peak	57
Figure 52.	Summary graph of 2700-2900 MHz measurements at Yerba Buena	58
Figure 53.	Summary graph of 2900-3100 MHz measurements at Grizzly Peak	59
Figure 54.	Summary graph of 2900-3100 MHz measurements at Yerba Buena	60
Figure 55.	Summary graph of 3100-3700 MHz measurements at Grizzly Peak	61
Figure 56.	Summary graph of 3100-3700 MHz measurements at Yerba Buena	62
Figure 57.	Azimuth-scan graph of 3700-4200 MHz measurements at Angel Island	63
Figure 58.	Summary graph of 4200-4400 MHz measurements at Grizzly Peak	64
Figure 59.	Summary graph of 4200-4400 MHz measurements at Yerba Buena	65
Figure 60.	Azimuth-scan graph of 4400-5000 MHz measurements at Angel Island	66
Figure 61.	Summary graph of 5000-5250 MHz measurements at Grizzly Peak	67

## **FIGURES** (Continued)

		Page
Figure 62.	Summary graph of 5000-5250 MHz measurements at Yerba Buena	68
Figure 63.	Summary graph of 5250-5925 MHz measurements at Grizzly Peak	69
Figure 64.	Summary graph of 5250-5925 MHz measurements at Yerba Buena	70
Figure 65.	Azimuth-scan graph of 5925-7125 MHz measurements at Angel Island	71
Figure 66.	Azimuth-scan graph of 7125-8500 MHz measurements at Angel Island	72
Figure 67.	Summary graph of 8500-10550 MHz measurements at Grizzly Peak	73
Figure 68.	Summary graph of 8500-10550 MHz measurements at Yerba Buena	74
Figure 69.	Azimuth-scan graph of 10550-13250 MHz measurements at Angel Island .	75
Figure 70.	Summary graph of 13250-14200 MHz measurements at Grizzly Peak	76
Figure 71.	Summary graph of 13250-14200 MHz measurements at Yerba Buena	77
Figure 72.	Azimuth-scan graph of 14200-15700 MHz measurements at Angel Island .	78
Figure 73.	Summary graph of 15700-17700 MHz measurements at Grizzly Peak	79
Figure 74.	Summary graph of 15700-17700 MHz measurements at Yerba Buena	80
Figure 75.	Azimuth-scan graph of 17700-19700 MHz measurements at Angel Island .	81
Figure B-1.	Functional diagram of the RSMS signal-processing path for measured data	109
Figure C-1.	ITS radio spectrum measurement system with antennas mounted for a broadband spectrum survey at a remote field site	120
Figure C-2.	Top and side view drawings of the RSMS	121
Figure C-3.	Front panel of the RSMS instrument racks	122
Figure C-4.	Block diagram of the RSMS receiver	123
Figure C-5.	Example calibration graph of noise figure and correction factor curves	128